CD-93-01 (LDV/LDT/SM/ICI/LIMO)

Dear Manufacturer:

SUBJECT: Cold CO Dynamometer/Road Load Issues

In a manufacturer guidance letter of August 10, 1992, (CD-92-09) on the same subject, EPA requested comments on a draft procedure for setting the dynamometer for Cold Temperature Certification testing. I would like to thank all of you who responded.

Comments were received both in support of the use of true 20 F road load as well as using a simulation of the hydrokinetic curve adjusted by 10%. We agree that true 20 F road load is the most technically correct approach for setting the dynamometer. However, implementation of the new 20 F requirements may impose facility and resource constraints in the short term. We realize that some manufacturers may need the flexibility that the hydrokinetic curve option offers. Also, EPA believes that Cold CO emissions will not be greatly effected by the choice of either dynamometer setting procedure. Therefore, at least during the phase-in period (1994-1995 model years), EPA will adopt the enclosed policy (Enclosure I) as originally proposed. This guidance should provide manufacturers with a balance between the flexibility necessary to implement a new program and the need to have uniform test procedures.

EPA proposed the August 10 draft procedure believing that slight differences in dynamometer settings would have very little effect on Cold CO emissions. One manufacturer supported this view and indicated it had test data to substantiate this claim. Other manufacturers expressed concern that different dynamometer settings might result in unequal treatment and therefore supported requiring all manufacturers to use true 20 F road load. EPA continues to believe that Cold CO emissions should not be greatly effected by the choice of dynamometer setting procedure. (As proposed in the NPRM, the 10% adjustment factors were intended to represent a good approximation of a true 20 F road load.) Further, EPA anticipated (and the comments confirmed) that some manufacturers would need facility flexibility for at least the first year or two of cold temperature testing.

Nevertheless, EPA believes that the best long term approach is to require the dynamometer to reproduce "true" road load. As you are aware, we are beginning the process of changing to large 48" single roll dynamometers reproducing true road load for standard temperature testing. When that conversion process is formally addressed, I anticipate similar requirements will be established for cold temperature testing.

One additional item was raised during our consideration of this issue: the relatively high sensitivity of cold temperature "quick check" times to previous vehicle operation and the time lapse before the "quick check" is run. Unlike warm temperature testing (where the "quick check" is performed after the second highway cycle), the vehicle may not be at a stable operating condition after the cold temperature FTP test. Further, multiple quick checks are not repeatable because of unstable vehicle operating temperatures. Since the purpose of the quick check is to verify the total load imposed (vehicle and dynamometer), it is important that quick check conditions be similar to when the dynamometer setting is initially determined.

Ford Motor Company investigated this problem and determined, for two different vehicle types, that varying driveline losses were responsible for the differing quick check times. Ford then developed a method for establishing cold temperature dynamometer settings that approximate conditions at the end of the cold temperature test. While EPA has accepted the Ford approach (as described in the enclosure), we do not wish to preclude other technically appropriate methods. Therefore, for the 1994 model year, manufacturers may self-approve other methods (following good engineering practice) for setting the dynamometer and confirming vehicle horsepower via quick check. As always, manufacturers must document this information in their Application for Certification.

Also, please note that the Cold CO confirmatory test program will be the first to utilize the new large diameter single roll electric dynamometers. However, the manufacturer also has the option of using other dynamometer configurations (including small diameter twin roll hydrokinetic units) provided Cold CO emissions are not decreased.

In the future, as additional experience is gained both in the industry and at EPA, we anticipate addressing this topic in a more formal manner. Should you have any questions regarding this procedure please contact your Certification Team representative.

Sincerely,

Robert E. Maxwell, Director
Certification Division
Office of Mobile Sources

Enclosures

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Enclosure I

We have received several inquiries on how manufacturers should establish vehicle road load values for cold temperature CO testing. In addition, questions concerning the dynamometer load setting have also been raised. The following provides guidance necessary to meet requirements for the Cold CO Test Procedure.

Vehicle Road Load

Manufacturers can establish 20 F road load value by using any of the following methods:

1. Perform a coastdown test at 20 F (±5. F) following a procedure comparable to the general procedures outlined in A/C 55C to establish road force as a function of speed. (Procedures yielding equivalent results are also acceptable.)

2. Adjust the road force equations in A/C 55C to reflect 20 F operation using a method that follows good engineering practice. (In lieu of developing the necessary correction factors, a 10% increase in the standard temperature road load values at all speeds is acceptable.)

3. For testing performed on a dynamometer with a single point (50mph) adjustment for road load (e.g., hydrokinetic) or an electric dynamometer modeling such a unit: Decrease the 55 to 45 mph coastdown time (used for dynamometer adjustment for normal temperature FTP testing) by 10%. For those vehicles which will receive confirmatory testing at EPA's laboratory, the manufacturer must provide the loaded coastdown speed vs time relationship for each test vehicle. All cold temperature EPA confirmatory testing will be conducted on a 48 inch electric dynamometer.

Dynamometer Adjustment

The manufacturer may adjust the dynamometer by one of the following methods:

1. Hydrokinetic (or fixed curve) dynamometers or dynamometers calibrated to simulate hydrokinetic dynamometers shall be adjusted to reproduce road force at 50 mph as is done for standard FTP testing. Such dynamometers shall be adjusted to reproduce the 55 to 45 mph coastdown time that represents the 20 F road load developed above. Alternatively, these dynamometers shall be adjusted to produce a 10% reduction in the 68 F coastdown target time (55 to 45 mph) using the loaded coastdown procedure at 20 F.

2. Electric (or adjustable curve) dynamometers shall be set to reproduce 20 F road force over the speed range of the test. Alternatively, the dynamometer shall be adjusted to produce a 10% reduction in the 68 F coastdown target time for each increment (55 to 45 mph, 45 to 35, 35 to 25, and 25 to 15 mph) using the loaded coastdown procedure at 20 F.

EPA Confirmatory Testing

EPA may elect to conduct confirmatory tests on vehicles tested by the manufacturers. In such instances EPA shall set its 48 inch electric dynamometer to reproduce, as closely as possible, the road force imposed during manufacturer testing. The manufacturer shall provide necessary information to assist EPA in setting its dynamometer. EPA will use the force curve generated by the manufacturer; EPA retain's the right to verify that the manufacturer has used good engineering practice.

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Enclosure II

Calibration of Electric Dynamometers
for Cold CO Testing

Objective: Develop a calibration procedure for electric dynamometers that produces a loading curve representative of the FTP conditions. The procedure is to be short, simple, and repeatable. Calibration is to match the adjusted roadload curve. A Quick-Check consisting of one extended (55-15 mph) loaded coastdown (conducted immediately following the Cold CO test) can be used to verify dynamometer loading.

1. Vehicles Chosen for Testing.

A. 2.3L Ranger (RWD). B. 3.8L Taurus (FWD).

11. Parameters Monitored.

A. Tire Temperatures (IR gun). B. Transmission/Transaxle Temperature. C. Axle Temperature (RWD only). D. Bag Emissions. E. Dynamometer Pit Temperature. F. Load Cell Temperature.

111. Testing

The dependence of driveline losses on vehicle temperatures/conditioning is illustrated in Attachment IV.

A. Obtain the signature of the vehicle's losses at the end of the Cold CO test defined by the parameters measured (A typical temperature profile of a Ranger during a 20 F CVS 75 can be seen on Attachment V).

B. Development of a vehicle warm-up cycle for dynamometer calibration.

1. Obtain the same signature as that of the Cold CO test while being shorter in duration.

2. Drive cycles attempted.
 a. 20 F Steady-state cycles.
 b. Two 20 F back-to-back 505 cycles (a temperature profile for a Ranger during this cycle can be seen on Attachment Vl).

IV. Description of the proposed dynamometer calibration procedure (see Attachment I for a detailed description).

A. Obtain the ambient roadload curve coefficients and multiply by 1.10 to adjust for 20 F (10% increased load).

B. Vehicle prepped and soaked at 20 F (12-36 hrs).

C. Vehicle conditioning -two back-to-back 505's.

D. Determine vehicle losses. Conduct a single extended coastdown (57-13 mph) with the proper inertia and dynamometer A,B,C coefficients set to zero to obtain drive-line losses.

E. Determine proper dynamometer loading curve (A,B,C coefficients). Subtract vehicle losses from the adjusted roadload to obtain the dynamometer loading (Attachment Vll graphically illustrates this subtraction).

F. Quick-Check: Conduct an extended coastdown (55-15 mph) immediately following the Cold CO test to verify that target coastdown times have been met (see Attachment II).

V. Summary of Results:

See Attachment III.

Vl. Open Issues:

1. How can we verify the dynamometer at calibration?

2. The number of points to use to define the driveline loss polynomial has to be determined.

3. Acceptance criteria for the Quick-Check coastdown times needs to be developed.

4. 20 F calibration for other dynamometers has not yet been investigated.

Ford Motor Company
Correlation Engineering
December 14, 1992

ATTACHMENT I

COLD TEMPERATURE SINGLE ROLL ELECTRIC DYNAMOMETER CALIBRATION PROCEDURE

Vehicle Preparation

1. Drain and fill the vehicle to 40% fuel tank capacity.

2. Set the drive tire pressure, at ambient conditions, to 4 psi above the vehicle manufacturer specification and the non-driven tires to 45 psi.

3. Soak the vehicle at 20 F for 12-36 hours.

Dynamometer Set-up

4. Obtain the ambient (68 F) road force coefficients (fO and f2) determined from A/C 55-C for the vehicle that will represent the vehicle configuration to be tested.

5. Adjust the road force coefficients to reflect the 10% increase in loading for 20 F calibration by multiplying the fO and the f2 road coefficients by 1.10.

6. Convert the adjusted road force coefficients to the units of the dynamometer (HP@ 50 mph) dividing fO by 7.5 to obtain the "A" coefficient and multiplying f2 by 333.333 to obtain the "C" coefficient.

7. Calculate the target coastdown time per AIC 55-C for the speed range of 55 to 15 mph in 10 mph intervals incorporating the adjusted vehicle weight for dynamometer testing by multiplying the vehicle test weight by 1.015 to reflect the 1.5% rotational mass of the drive wheels on the dynamometer per A/C 55-C.

8. Set the dynamometer coefficients as calculated in step 6 and the inertia for the vehicle to be calibrated.

9. Ensure the test cell is 20 +3 F.

10. Perform the dynamometer warm-up (10 minutes @50 mph).

Vehicle Conditioning

11. Place the vehicle on the dynamometer at TDC and initiate the dynamometer to jog the vehicle drive wheels for alignment on the roll.

12. Restrain the vehicle without inducing any undue vertical forces on the drive tires.

13. Adjust the drive tire pressure to the vehicle manufacturer recommended pressure and the non-driven tires to 45 psi.

14. Condition the vehicle by conducting two back-to-back FTP 505 driving cycles.

Determination of Vehicle Losses

15. At the end of the 505's, set the dynamometer A, B, C coefficients to zero.

16. Shift the transmission in neutral, and within 30 seconds of the end of the second 505, initiate the dynamometer to motor the vehicle to 62 mph.

17. Conduct one 57-13 mph extended coastdown and simultaneously, measure the forces at 2 mph intervals. (i.e. 56, 54, 52 mph...)

18. Obtain the measured A, B, C coefficients from the dynamometer controller.

19. Subtract the vehicles losses determined in step 18 from the dynamometer coefficients calculated in step 6 to acquire the dynamometer Cold CO testing coefficients.

ATTACHMENT II

COLD CO QUICK-CHECK PROCEDURE

Validation: A Quick-Check test consisting of one extended (55-15 mph) loaded coastdown (conducted immediately following the Cold CO test) will be used to verify dynamometer loading.

1. Within 30 seconds of the end of the EPA-75 Cold CO test, shift the vehicle in neutral and initiate the dynamometer to motor the vehicle to 62 mph.

2. Conduct one extended (55-15 mph) coastdown and measure the coastdown times in 10 mph intervals.

3. The coastdown times should be compared to the target times calculated in step 7 of Attachment 1. (Acceptance limits are TBD)

Attachments 3 - 7 are stored as CD9301-1.pcx through CD9301-5.pcx, respectively.